Increasing Industry-Academia Collaboration

Types of Regional Software Engineering Companies and Their Needs from Academia

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Improvements in the industry-academia collaboration have been argued to bring wide range of benefits for both communities, increasing innovation capacity for industry and providing academy access to real-world environments. However, building close collaborative ties between SE industry and academia has been slow and difficult. Academia has struggled to keep pace with SE engineering profession in reacting to new platforms and trends and in creating realistic SE learning environments for the students. Consequently, the students' initial experiences in the industry have turned out to be rather different than their education. This paper describes early efforts to increase industry-academia collaboration in the Finnish region of South Savo. Through the process of searching, contacting, and interviewing regional SE companies, we began to see similarities and differences between SE companies in the region. In this paper, we describe five emerged archetypes of regional SE companies and report their preferences for industry-academia collaboration.

CCS CONCEPTS • Computing education • Computing industry • Geographic characteristics

Additional Keywords and Phrases: Industry-Academia collaboration, software quality assurance, types of Software Engineering companies.

1 INTRODUCTION

Research collaboration between software engineering (SE) industry and academia has been an important discussion topic in the SE community already for more than three decades [1, 2, 3]. The industry-academia collaboration has been argued to bring wide range of benefits for both communities, improving innovation capacity for industry, and providing academy access to real-world environments [1, 3]. However, building close collaborative ties between SE industry and academia has been slow and difficult [1, 3]. Compared to the amount of activities in each of the two communities, the level of joint industry-academia collaborations has been reported to be very low [4]. Consequently, academia has struggled to keep pace with SE engineering profession in reacting to new platforms and trends and in creating realistic SE learning environments for the students [2]. This has made it challenging for the students to acquire the latest technological skills and necessary soft skills for the collaboration to develop large-scale software projects [2]. While the industry expects competent graduates, the students' initial experiences in the industry have turned out to be rather different than their education [2].

The industry-academia gap has been often recommended to be reduced by close collaboration and co-production. Software Engineering industry should spend more time with academia and communicate their real problems and share information about the latest methodologies, while academia should strengthen its ties to the industry to create an environment for real-life experience for its students [1, 2]. We have started to work towards reducing the gap between industry and higher education in the Finnish region of South Savo. As a first step of our project, we identified those SE companies in the region with whom collaboration is likely to lead to most impactful results. To this end, we searched and interviewed SE companies for understanding better their characteristics and willingness to collaborate with academia. In doing so, we begun to see similarities and differences between the 22 interviewed companies, leading to five emerging SE company archetypes. We then used these archetypes in categorizing interviewed companies to understand better the unique characteristics and opportunities for collaboration of each type of company.

This paper describes the emerged SE company archetypes and reports their preferences for industry-academia collaboration. The remainder of the paper is organized as follows. First, we describe our research project and method of analysis. Section 3 then presents the results of our analysis. Finally, section 4 discusses the findings and concludes the paper.

2 RESEARCH PROJECT AND METHODS

The *Establishment of Xamk Software Quality Assurance Workshop* -project (SQAW) [5] seeks to intensify Software Quality Assurance (SQA) -related collaboration between industry and academia in the Finnish region of South Savo. The benefits of such an objective are mutual. SE students will be able to learn real-life software development contexts and build ties with local software companies already while studying. Regional software companies, on the other hand, will benefit from students exploring the latest SQA topics and technologies. Since utilizing SQA tools and automating SQA activities have been found to require high learning curve at the beginning, while eventually improving speed and reactivity to changes [6], the project focuses to develop:

- new collaborative models between higher education and software companies to share SQA-related knowledge and to guide further exploration.
- virtual Software Quality Assurance Workshop that allows access for students and software companies to use SQA-related tools.

The project has been awarded European regional development funding by South Savo regional council, and is to be implemented from September 1, 2021 to June 30, 2023. In the long term, the project seeks to improve the viability of the software industry in the region and the ability for higher education to respond to the needs of regional software companies.

As a first step towards achieving the project goals, we wanted to create a better understanding of the software development companies in the region. To this end, we developed a structured questionnaire for assessing companies' business and products, SE activities, quality assurance practices, and interest in collaboration [7]. Our plan was to contact relevant regional SE companies and fill the questionnaire together with each company that agreed to be interviewed. For identifying regional SE companies, we searched for companies located in South Savo having Finnish standard industrial classification [8]: "*Computer programming, consultancy and related activities*". This search resulted with 168 companies. Since our intention was to increase companies' SQA competences, we wanted to exclude those companies that focused primarily on computer facilities management, software and hardware consultancy, or other information technology and computer service

activities. By narrowing down our search for companies having sub-classification:" *Computer programming activities*", we resulted with 103 identified companies. As our intention was also to develop new collaborative models between higher education and software companies, we reasoned that collaboration with limited companies was most likely to lead with impactful results. By excluding other company types, such as private trader and co-operative, our list of potential companies were reduced to 65 companies. In the next phase, we started to investigate closer the identified potential companies. We soon realized that many of the companies did not have a web site or contact information available. We believed these companies were likely to be *shell companies* that would benefit more from business consultancy, rather than from collaboration with us. At the end, we identified approximately 30 potential companies, from which 22 companies agreed to be interviewed.

Through the process of searching, contacting, and interviewing, we began to see similarities and differences between SE companies in the region. Archetypes of SE companies began to emerge, largely based on source of income, degree of productization, number of offices, and number of employees (Table 1). These emerging SE company archetypes guided us to focus our efforts particularly towards those companies, with whom we believed to achieve most impactful results. We initially believed that web-page development done by *digital marketing companies* would not benefit much from increasing SQA-competences. We also decided not to focus on *cloud services companies*, as they often seemed to subcontract their software development to others and wanted to concentrate business development themselves. Finally, although many *subcontractors* were experienced software developers, their unwillingness to grow would not create us sufficient scale in intensifying industry-academia collaboration. Therefore, we initially decided to focus particularly to *software project companies* and *software product companies*.

Table 1. Emerged SE company archetypes and their estimated interest for participating in the SQAW -project.

SE company archetype	**Description**	**Estimated interest for participating in the SQAW-project**
Digital marketing company	Develops digital solutions to support companies' digital marketing and e-commerce activities. Development focuses on graphical design, user experience and web-page development.	As large portion of their work is creative by nature, rather than software development, would they benefit from increasing their SQA competence?
Cloud services company	Offers services on demand to companies and customers over the internet. Primary focus is typically on business development. Software development is often subcontracted.	Would benefit in getting to know better regional SE companies that could potentially be their subcontractors.
Software project company	Offers SE services to many customers. Develops wide range of software solutions and may also have software products and services of their own.	Networking with other SE companies leads to identification of new business opportunities. Collaboration with academia improves competence development and recruiting.
Subcontractor	Experienced developer(s) serving long-term customer(s). Business is stabilized with very little intentions to grow.	Would like to get to know other regional SE-companies for sharing experiences and bidding for larger projects. Would be interested also to share their experiences with students.
Software product company	Long-term product business from software they have developed themselves. May have already been acquired by a larger company, in which case the decision-power has already been moved to the headquarters.	Have interest in recruiting students and take advantage of research results in their own software product development activities.

These emerged SE company archetypes (Table 1) were first presented and discussed with the steering group of the SQAW-project consisting of two representatives from SE companies, two from an educational institute, one from regional development organization, and one from the regional council. The discussions in the steering group meeting revealed that the proposed SE company archetypes resembled well with the steering group members' own experiences. However, contrary to our view of digital marketing companies benefitting little from the project, the steering group members argued that digital marketing companies would also benefit from increased SQA competence and that many of the SE graduates are hired by the digital marketing companies. The SE company archetypes were also presented and discussed in a workshop, in which 8 regional SE companies participated. The proposed SE company archetypes were well accepted with no objections given. These two occasions, organized for discussing the SE company archetypes can be considered as acts of *member checking* [9], with the intention to reduce threats to validity.

Once we had identified different types of regional SE-companies, we wanted to understand better their expectations from the industry-academia collaboration. To this end, we categorized each of the 22 interviewed companies, as presented by Table 2, and analyzed each group of companies separately.

Table 2. Number of interviewed companies by each SE company archetype

Type of company	**Interviewed companies**
Digital marketing company	1
Cloud services company	3
Software project company	3
Subcontractor	4
Software product company	11
Total:	**22**

We particularly analyzed data related to three questions, in which respondents were to rate items on the scale from 1=not important/interesting to 5=very important/interesting (Table 3).

Table 3. Three interview questions, on a scale of 1=not important/interesting to 5=very important/interesting, probing companies' needs and preferences from academia.

How important you consider following skills from your new employees?	**How interesting you find following ways to utilize students in your activities?**	**How interesting you find following ways to collaborate with academia?**
• Programming • Software architecture and object-oriented design • SE methods (e.g. agile development) • Software quality assurance • Problem solving and logical reasoning • Teamwork	• Practical assignments without salary • Internship • Final project • Hiring for part-time worker • Hiring for full-time worker • Subcontracting through university's projects	• Taking part in teaching • Providing research ideas and assignments • Utilizing investigation and development results • Participating in joint R&D projects

3 RESULTS

Our analysis revealed differences on how different SE company archetypes preferred SE graduates' skills (Figure 1). Skills related programming, software architecture and object-oriented design were valued particularly by subcontractors, software project companies, and software product companies. These skills were less important for digital marketing companies and cloud services companies, who instead seemed to prefer more knowledgeability of SE development methods. It is noteworthy that all types of companies highly valued skills related to problem solving and logical reasoning.

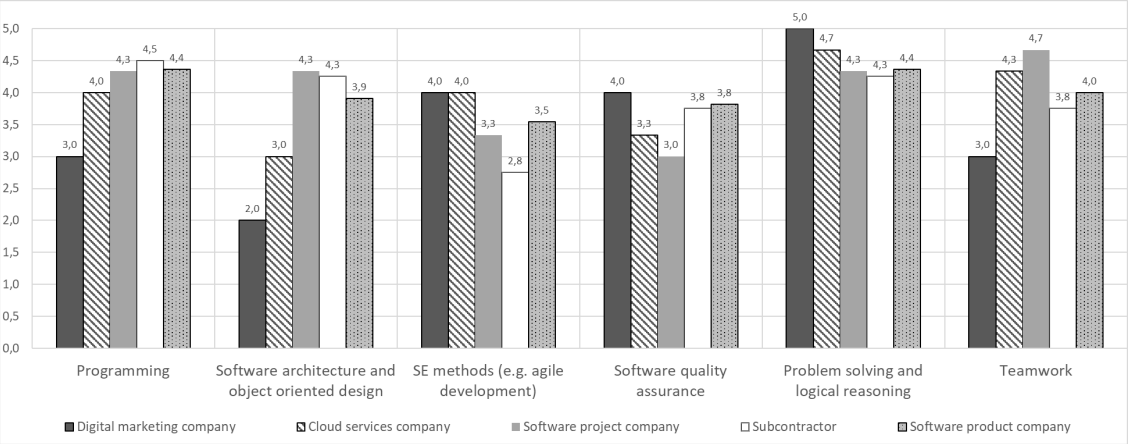

Figure 1. SE companies' expectations and preferences of SE graduates' skills.

SE companies' interest to utilize student work is presented in Figure 2. The results reveal that all types of SE companies showed interest in collaborating with students in their final project and in hiring students as full-time employees. The results provided supporting evidence for steering group's comment, arguing that digital marketing companies are among most interested in working with SE graduates. The results also revealed that subcontractors and software product companies are currently among the least interested to utilize student work. In subcontractors' case, this could be explained by their low desire to grow. Software product companies' low interest to utilize student work is more surprising. However, this resembles with our experiences of having currently low industry-academia ties with software product companies.

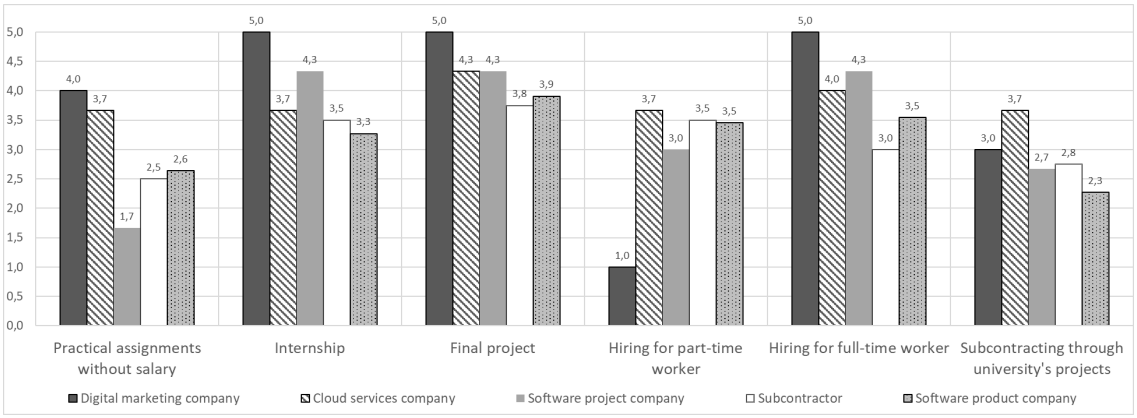

Figure 2. SE companies' preferences of utilizing SE students.

Figure 3 depicts SE companies' interests to collaborate with universities. These findings suggest that SE companies show interest in industry-academia collaboration. Most of the companies were interested in providing research ideas and assignments, utilizing the research results, and participating in joint R&D projects. Subcontractors seemed to be least interested in such collaboration. This could be explained by their low availability of resources.

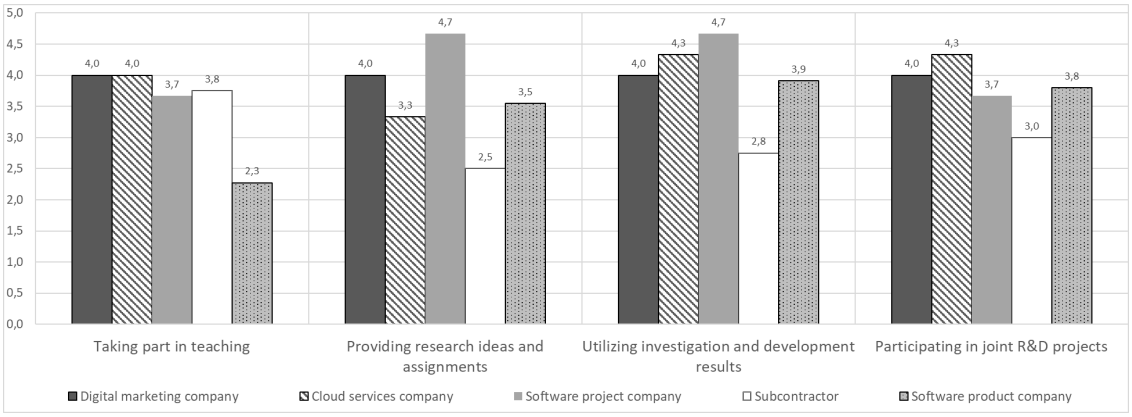

Figure 3. SE companies' preferences of collaborating with universities.

4 DISCUSSION

In addressing key challenges of Industry-Academia collaboration, Lethbridge and his colleagues [10] have argued that academia needs to learn more about specialties and educational needs of different types of SE companies. In this paper we identified five different types of SE companies and analyzed their preferences in terms of desired skills of new employees and willingness to collaborate with academia. Our findings reveal that there are commonalities and differences between the five types of SE companies. All the companies highly valued problem solving and logical reasoning skills. However, the differences and similarities in appreciating methodological and technological skills suggest that the five SE company archetypes may be further combined into two groups (Figure 4). Three types of companies distinctively valued skills related programming, software

architecture, and object-oriented design. This suggests that software project-, software product-, and subcontractor-companies, all have interest in *technical* capabilities of SE. Two types of companies, however, seemed less interested about technical side of SE, and were more interested about development methods instead. Since these companies worked on digital marketing and cloud-services business, their focus is primarily on ways of attracting users. These companies are likely to be interested on topics such as user-centered development, digital service design, graphical design, and software business. In addressing the needs of such companies, the academia should also promote the software engineering program as a sociotechnical profession and try to appeal to a wider range of prospective students to change the introvert male stereotype of engineers [2].

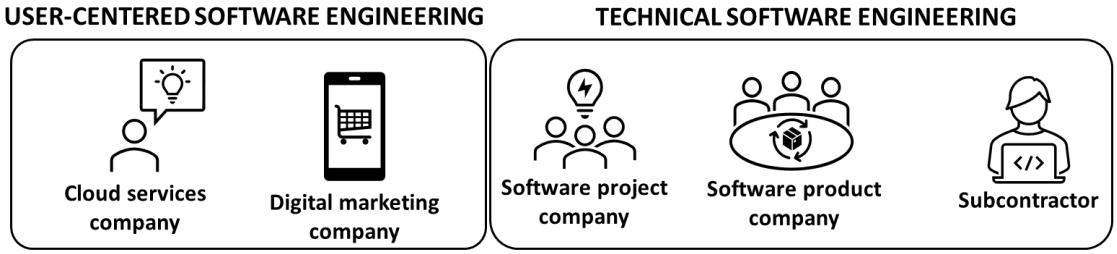

Figure 4. Grouping of SE company archetypes based on their preferences of employees' skills.

Our study revealed that SE companies in the region showed interest in working closely with SE students and collaborating with universities. This creates us a fruitful basis for us in continue our project activities, with the objective of creating new collaborative models between industry and academia. When continuing our work, we shall follow the guidelines offered by [1], arguing that model of industry-academia collaboration needs to: (i) foster research knowledge co-creation through joint problem definition and solving, (ii) promote continuous dialogue to help align the expectations of researchers and practitioners, (iii) ensure that the research output created in the project is transformed into results with practical relevance and benefit for the partners, and (iv) ensure that such results are effectively transferred to and exploited by the partners [1].

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Authors' Research Background

*The form itself will not be published.

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